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Lawler's paper on doing the flow analysis

Oak Ridge National Laboratory — Health Physics Division

Subject: Studies on Overflow at White Oak Dam

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Studies on Overflow at White Oak Dam

During the latter part of March, 1949, a study on overflow water at White Oak Dam was undertaken to determine the effects of a flood on the discharge of radioactivity over the Coffer Dam and into Clinch River.

The first sampling of overflow water was begun at 11:30 A.M. on 3-25-49, following a rainfall of 0.6 inches from 4:00 A.M. to 8:00 A.M. Water was flowing over the top of the coffer piling approximately one inch at the collection hour of the first sample. A second sample was collected at 2:15 P.M. No other samples were obtained on 3-25-49 due to water level subsiding to a level below the top of the piling.

The next day, 3-26-49, a rainfall of 0.08 inch fell from 2:00 A.M. until 4:00 P.M. Since the water level was near the top of the piling previous to this small rainfall, overflow of the piling started again at approximately 8:30 A.M. Sampling was begun at 9:00 A.M. and continued at 2 hour intervals until 5:00 P.M. Shortly after the latter hour the lake again fell to a level below the top of the coffer piling.

A third rain in as many days fell from 2:00 A.M. to 6:00 P.M., 3-27-49, which amounted to 0.51 inch.

Periodic sampling was started at 8:00 A.M., 3-27-49, and continued each two hours through 12:00 M. Thereafter, beginning at 4:00 A.M., 3-28-49, samples were collected each two hours during the overflow, which continued through 6:00 P.M.

Beginning at 1:00 A.M. and continuing through 11:00 P.M. on 3-31-49 a fourth rainfall amounting to 0.41 inch was recorded at X-10. Overflow of the coffer piling at about 6:00 A.M. resulted from this rain.

Four samples were collected, beginning at 6:20 A.M. and continuing through 3:20 P.M. At the latter hour, samples were collected going through the gate and over the piling for comparison purposes.

In the Laboratory, three 50 ml samples from each original sample were boiled down to near dryness, transferred to porcelain dishes, and brought to complete dryness under a 375 watt heat lamp. These samples were counted in a beta chamber at approximately 10% geometry.

Following are the results obtained from this study with approximate number of curies going over White Oak Dam and the probable concentration (μc/cc) in Clinch River during these flood conditions. For comparison purposes the average number of curies per day going over White Oak Dam and the probable concentration (μc/cc) in Clinch River are given for a four week period preceding the overflow and for a 26 day period following the flood. Also given are average deviations under flood conditions, from both of these periods.

Overflow Data

Date	Hours of Sampling	Rain-fall	Duration of Rain	Time of Peak at Dam	Hours Over Piling	10% Geo. Gross β c/m/ml	Average Discharge /day cfs	Curies Discharged (β+δ)
3-25-49	11:30 am					21		
"	2:15 pm					17		
"		0.60"	4:00 am-8:00 am	1:30 pm	11 am - 4 pm		33.0	10.90
3-26-49	9:00 am					17		
"	11:00 am					16		
"	1:00 pm					16		
"	3:00 pm					18		
"	5:00 pm					17		
"		0.08"	2:00 am-4:00 pm	12:30 pm	9 am - 5:30 pm		36.4	11.89
3-27-49	8:00 pm					15		
"	10:00 pm					15		
"	12:00 m					15		
"		0.51"	2:00 am-6:00 pm	12:00 m	8 pm - 12 m		35.0	10.54
3-28-49	4:00 am					16		
"	6:00 am					16		
"	8:00 am					16		
"	10:00 am					16		
"	12:00 n					18		
"	2:00 pm					16		
"	4:00 pm					19		
"	6:00 pm					16		
"					12 m - 6:30 pm		36.5	11.72
3-31-49	6:20 am					16		
"	8:30 am					13		
"	12:00 n					13		
"	3:20 pm					16		
"		0.41"	1:00 am - 11:00 pm	1:00 pm	6:20 am-4:00 pm		34.2	12.83

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Average curies/day discharged:

previous to flood (2-20-49 - 3-19-49)	3.08
during flood (3-25-49 - 3-28-49 and 3-31-49)	11.57
following flood (4-1-49 - 4-26-49)	4.09

Probable average concentration* in Clinch River:

previous to flood (2-20-49 - 3-19-49)	2.1×10^{-7} μc/cc
during flood (3-25-49 - 3-28-49 and 3-31-49)	12.6×10^{-7} μc/cc
following flood (4-1-49 - 4-26-49)	4.2×10^{-7} μc/cc

Deviation of probable average concentration* in Clinch River:

flood period (3-25-49 - 3-28-49 and 3-31-49) from previous period (2-20-49 - 3-19-49)	+524.0%
flood period (3-25-49 - 3-28-49 and 3-31-49) from post flood period (4-1-49 - 4-26-49)	+223.0%

The second study of radioactivity overflowing White Oak Dam during flood conditions was made on 4-28-49 and 4-29-49 following a heavy rainfall on 4-27-49.

On 4-27-49, beginning at 4:00 A.M. and continuing through 11:30 P.M., a rainfall of 2.21 inches was recorded at X-10. Since the rainfall was steady, there was not an overflow of the coffer piling at White Oak Dam until after midnight and after the rain had ceased. Sampling of the overflow water was begun at 1:00 A.M., 4-28-49, and continued at approximately two hour intervals, because of additional rainfall, until 11:00 P.M., 4-29-49.

As mentioned above, additional rainfall other than the initial 2.21 inches which fell on 4-27-49 made it necessary to sample the overflow at White Oak Dam over a 46 hour period. No samples were taken from 11:20 A.M. to 7:00 P.M., 4-29-49, due to the water level subsiding to a level below the top of the coffer piling.

A second rainfall 0.21 inch fell from 1:00 - 4:00 A.M., 4-28-49. Then, a rainfall of 0.10 inch fell on 4-29-49 from 3:00 P.M. to 6:00 P.M.

*Calculated using as a dilution factor the ratio of White Oak Lake discharge to the flow of Clinch River.

The combined rainfall for the three day period 4-27-49 to 4-29-49 inclusive amounted to 2.52 inches. The flow at White Oak Dam peaked at 10:15 P.M., 4-28-49.

During this study the gate at White Oak Dam was set on 2.0 feet.

After collection, a 50 ml portion of each sample was transferred into a 100 ml size tube, positioned in centrifuge, and centrifuged for five minutes. The supernatant of each sample was decanted into a separate 100 ml beaker and reduced to near dryness. It was then transferred into an aluminum dish and brought to dryness under a 375 watt heat lamp. The sediment of each sample was micro-washed into a separate aluminum dish and also brought to dryness under a heat lamp.

After cooling to room temperature, the samples were counted in a beta chamber at approximately 10% geometry.

Following (page 6) in tabular form are the results, reported at 10% geometry, obtained from this study. Also, for comparative purposes, the approximate number of curies overflowing White Oak Dam and the concentration in Clinch River are given for the flood period, a 26 day period previous to the flood, and for a four week period following the three day flood.

Approximately two hours previous to the peak of the overflow, 10:15 P.M. on 4-28-49, it is noted that about 50% of the total activity of a 50 ml sample was adsorbed on the silt. This increase in activity of the silt was due to an increased amount of silt being swept from the bottom of White Oak Lake and suspended in the overflow water a short time before the peak of the flood. At the time of the peak of the overflow, water with the greatest amount of silt suspended in it had been forced ahead, and the percentage of activity in both the supernatant and the silt was about the same as their respective averages for the overflow period.

Also, note an increase in percentage of the total activity contained in the sediment or silt from 7:00 P.M. to 11:00 P.M., 4-29-49. This again was due to an increase in the quantity of silt suspended in the overflow due to the 0.10 inch rain which fell from 3:00 P.M. to 6:30 P.M. on this day, causing overflow of the piling again.

Centrifugal Separation Data
on Overflow at White Oak Dam

Date and Time of Sampling		Supernatant, c/m 50 ml at 10% Geo.	Silt, c/m at 10% Geo.	Tot. Act.c/m 50 ml sample Supernatant plus silt	% of Total Activity in Supernatant	% of Total Activity in Silt
4-28-49	1:00 A.M.	527	113	640	81.25	18.75
4-28-49	3:30 A.M.	587	164	751	78.16	21.84
4-28-49	5:30 A.M.	486	226	712	68.25	31.75
4-28-49	7:30 A.M.	473	173	646	73.21	26.79
4-28-49	9:20 A.M.	563	219	782	71.99	28.01
4-28-49	12:15 P.M.	507	107	614	82.57	17.43
4-28-49	2:15 P.M.	471	158	629	74.88	25.12
4-28-49	4:15 P.M.	433	107	540	80.18	19.82
4-28-49	6:15 P.M.	229	169	398	57.53	42.47
4-28-49	8:00 P.M.	205	201	406	50.49	49.51
4-28-49	10:00 P.M.*	384	193	577	66.55	33.45
4-28-49	12:00 M	297	130	427	69.55	30.45
4-29-49	2:00 A.M.	290	135	425	68.23	31.77
4-29-49	4:00 A.M.	286	157	443	64.55	35.45
4-29-49	6:00 A.M.	282	121	403	69.97	30.03
4-29-49	9:00 A.M.	295	125	420	70.23	29.77
4-29-49	11:20 A.M.	270	116	386	69.94	30.06
4-29-49	7:00 P.M.	214	119	333	64.26	35.74
4-29-49	9:00 P.M.	209	142	351	59.54	40.46
4-29-49	11:00 P.M.	221	231	452	48.89	51.11
Average Percentage of Total Activity					68.51	31.49

*White Oak flow peaked at approximately 10:15 P.M. on 4-28-49.

A short summary of curies/day discharged during the period 4-27 to 4-29-49 inclusive and the average concentration in Clinch River compared to a 26 day period previous to this flood, and to a four week period following the overflow follows:

Average curies/day discharged:

previous to flood (4-1-49 - 4-26-49)	4.09
during flood (4-27-49 - 4-29-49)	9.80
following flood (5-1-49 - 5-28-49)	2.51

Probable average concentration* in Clinch River:

previous to flood (4-1-49 - 4-26-49)	4.19×10^{-7} µc/cc
during flood (4-27-49 - 4-29-49)	6.20×10^{-7} µc/cc
following flood (5-1-49 - 5-28-49)	1.40×10^{-7} µc/cc

Deviation of probable average concentration* in Clinch River:

flood period (4-27-49 - 4-29-49) from previous period (4-1-49 - 4-26-49)	+51.6%
flood period (4-27-49 - 4-29-49) from post flood period (5-1-49 - 5-28-49)	+342.8%

Summary

During the flood period 3-25, 26, 27, 28, 29, 31-49, curies discharged over White Oak Dam increased 3.2 times over the average for the 26 day period previous to the flood and the 4 week period following the flood. Compared to these same periods the probable average concentration in Clinch River increased four fold during the flood days.

For the latter flood period, 4-27-49 to 4-29-49, the curies discharged increased 1.9 times over the average for the two periods, 4-1-49 to 4-26-49 and 5-1-49 to 5-28-49, while the probable average concentration in Clinch River increased 2.2 times over the average for these two non-flood periods.

*Calculated using as a dilution factor the ratio of White Oak Lake discharge to the flow of Clinch River.

Due to local rains and flood conditions in this immediate area the concentration of activity in Clinch River during a flood is not directly proportional to the increase in the discharge of curies over White Oak Dam. The concentration may also be greatly increased at times when the discharge from Norris Dam is very low during a local flood in the White Oak Creek drainage area.

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